## Pollution Prevention Opportunities for Printed Circuit Board Manufacturing

The keys to pollution prevention in printed circuit board manufacturing are to minimize chemical dragout; minimize the amount of water used for rinsing; and the recovery, reuse, and recycle of copper.

| Y/N | Opportunities | Comments |
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| I. | Material Handling and Storage | |
| ____ | Control inventory | Do not allow material to exceed shelf life. Use materials on a first-in, first-out basis. |
| ____ | Buy appropriate amounts | Buy materials in small quantities if only small amounts are required. |
| ____ | Cover outdoor storage | Divert clean stormwater away from storage areas. |
| ____ | Install spill containment | Spills can be contained and managed. Reduces wastewater treatment upsets. |
| II. | Dragout | |
| ____ | Lenghthen dragout time | Allows more chemical to drip back to process tank, so reduces the amount of chemical introduced in rinsewater. |
| ____ | Establish dragout timing | Post dragout times at tanks to remind employees. |
| ____ | Install drain boards or drip guards | Boards and guards minimize spillage between tanks and are sloped away from rinse tanks so dragout fluids drain back to plating tanks. |
| ____ | Install drip bars | Drip bars allow personnel to drain parts hands free without waiting, so personnel will not use too short a dragout time. |
| ____ | Mechanize dragout | Eliminates possibility of employee using too short a dragout time, maintains product QA/QC standards if timing is set properly. |
| ____ | Reduce pockets on parts | Place parts on dragout rack to minimize chances of chemical pooling in corners or in other pockets. |
| III. | Rinsing | |
| ____ | Use static rinses | Static rinses usually follow the plating bath and capture the most concentrated dragout for returning to the plating bath or for metal recovery. |
| ____ | Use countercurrent rinses | These rinses dramatically reduce the amount of water required for rinsing and therefore reduce the amount of wastewater to be treated or sent for metal recovery. |

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| ____ | Use conductivity sensor | This sensor gives an indication of the cleanliness of the rinsewater. Sensor can be designed to trigger clean rinsewater flow when the tank water gets too dirty. |
| ____ | Use spray or fog rinsing | Reduces rinsewater quantity required and can also be used over plating baths. |
| ____ | Use foot pump or photosensor to activate rinse | These items allow use of water only when processing parts. A photosensor may be used on automatic plating lines. |
| ____ | Agitate rinse bath | Agitation promotes better rinsing. Agitate water or part. |
| ____ | Install flow restrictors | Restrictors automatically reduce the amount of rinsewater, so operators do not need to adjust inlet valves. |

IV. Material Recycle, Reuse, and Recovery

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| ____ | Reuse deionized rinsewater | Depending on product, this rinsewater can be reused in a plating bath as evaporated water makeup. |
| ____ | Ion exchange on rinsewater | Ion exchange can be used to concentrate metals in rinsewaters and metal can be recovered from the ion exchange acid regenerant stream. |
| ____ | Reuse spent acid/alkaline | Spent acid can be used to neutralize an alkaline waste stream. Spent alkali can be used to neutralize an acid waste stream. |
| ____ | Reverse osmosis | Concentrate dragout for reuse in plating bath; the water stream can also be reused. |
| ____ | Evaporation | Concentrate dragout for reuse; the water condensate can also be reused. |
| ____ | Electrowinning | Recover metals from spent plating baths or ion exchange acid regenerant streams. |
| ____ | Reuse mild acid rinsewater | Use mild acid rinsewater as influent to rinse following alkaline cleaning bath. Improves efficiency of rinse, so less rinsewater is required. |
| ____ | Recover copper sulfate | On microetch line, recover copper sulfate crystals directly from etch tank and reuse crystals in copper electroplating baths. |
| ____ | Recover particulate copper | On debur operation, recover particulate copper using centrifuge or paper filter. Reuse water |
| ____ | Reclaim etchant | Send etchant to an off-site reclaimer instead of treating etchant in wastewater treatment system. |

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| ____ | Reuse spent acids/alkalines | Use spent acids and alkaline solutions for neutralization reactions in wastewater treatment system. |
| ____ | Recycle photoresist stripper | Decant spent photoresist stripper from polymer residue and recycle stripper. Do not discharge spent stripper to wastewater treatment system. |

V. Process Modification

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| ____ | Eliminate chelated baths | Change to a nonchelated plating bath to improve metal wastewater treatment. Chelated streams make it difficult to precipitate metal in wastewater treatment system. |
| ____ | Segregate waste streams | Increases recovery and treatment technology efficiencies. Acidic vs. alkaline. Concentrated metal (spent baths) vs. dilute metal (rinsewater streams). Chelated vs. nonchelated streams. |
| ____ | Convert to dry floor | Reduces chances of spills reaching floor drains or causing upset in wastewater pretreatment plant. |
| ____ | Buy efficient etch machine | An efficient etch machine results in less copper in rinsewater. |
| ____ | Increase bath temperature | Evaporates bath water so relatively clean waste rinsewater can be reused as bath makeup water. Reduces solution viscosity, so more chemical drains back to process tank during dragout. |

VI. Process Operation and Maintenance

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| ____ | Use deionized (DI) water | Use DI water in plating baths, static rinses, and if practical in running rinses. DI water reduces impurities in the plating bath to extend its life and minimizes the precipitation of minerals in water as sludge. |
| ____ | Optimize bath concentrations | Only replace plating chemical when necessary. Lengthens bath life. Replace chemicals on electroless copper baths to extend bath life. Automate chemical replacement through online analyzers and chemical flow meters. |
| ____ | Install bath filters | Filters can remove particulates and trace contaminant organics in the process bath, lengthens bath life. Use filter that can be unrolled, cleaned and reused. |

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| ____ | Raw material purity | Use high quality raw materials in bath so bath will not become contaminated as quickly. |
| ____ | Reduce bath dumps | Optimize bath operation so bath dumps are infrequent. |
| ____ | Spill cleanup procedures | Establish procedures for what to do with a spill. Mitigates chance of spill being discharged to wastewater treatment plant. |
| ____ | Perform preventive maintenance | Routinely check for leaks in valves and and fittings. Repair immediately. |
| ____ | Electroless tanks | Use continuous passivation on stainless steel components in electroless plating tanks to prevent copper plate-out. Copper plate-out needs to be stripped with nitric acid. Reduces amount of spent nitric acid that needs to be treated. |

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